Episode Book

EPISODE #5917

The Women Who Were Computers Before Computers Existed

PUBLISHED	12 October 2026 at 19:09 UTC
DURATION	22:49
LISTEN	myweirdprompts.com/episode/human-computers-before-machines-86740/
HOSTS	Corn, Herman, Hilbert
SCRIPT MODEL	deepseek-flash
VOICES	chatterbox-regular (chatterbox-local)
PIPELINE	V5.4
SOURCES	13 cited by the research (listed at the end)
BOOK GENERATED	19 October 2026 at 17:41 UTC

SYNOPSIS

Before "computer" meant a machine, it was a job title — held for centuries by people, and by the 1940s, mostly by women. This episode reconstructs the actual desk: pre-printed forms, mathematical tables, colored pencils, and mechanical calculators with hand cranks. From the WPA's Mathematical Tables Project, where one or two people in a 450-person workforce could do division, to Los Alamos, where Naomi Livesay rewired IBM plug boards and hand-checked the machine's output, to Bletchley Park's Bombe operators working from footstools. What emerges is a story about designing computation at scale before computers existed — and the factory architecture, error-checking, and even the accounting units (kilogirls, girl-years) that made it work.

TRANSCRIPT



Corn

The word "computer" was a job title before it was a machine. And not that long ago, either. Daniel sent us a prompt about the people who held it, and he's after something specific. Not the usual "unsung heroes" framing. He wants to know what the job was actually like. Were these mathematical prodigies, people holding formulas in their heads? Or were they closer to operators of a system, following procedures step by step, working from tables, pencils and paper? He asks where the line sat between the people who designed the methods and the people who executed them, and he wants the desk reconstructed. What did a worker have in front of her, what was she handed, what was she expected to produce?



Herman

And then the bigger question underneath it, which is the one I find hard. How do you run computation at scale before you have a computer? Not "how did a clever person do a hard sum" but how did you get thousands of people doing sums at once and trust the answer? That's an engineering problem. That's a factory design problem.



Corn

So let's reconstruct the desk.



Herman

Start with the word itself. "Computer" as a term for a person shows up in writing in 1613. It was a job title for centuries. Astronomy, navigation, engineering, ballistics, meteorology, and then wartime codebreaking. And here's the tension we should hold onto for the whole episode: the same job title covered an enormous range. At one end you have relief workers doing single-digit addition. At the other you have people with doctorates in mathematics. Same word.



Corn

So the first thing to clear up is the savant thing.



Herman

Almost entirely wrong. Turing, in 1950, wrote about what a human computer is supposed to be, and his definition is the opposite of a prodigy. He said a human computer is supposed to be following fixed rules, and he has no authority to deviate from them in any detail. That's a job description. That's a component spec.



Corn

That's a machine part.



Herman

And the Mathematical Tables Project is the clearest case of that. This was a Works Progress Administration project, New Deal relief work, ran from 1938 to 1948. At its peak, roughly four hundred and fifty people doing computation. And here's the description of what they could do. Largely unskilled. Most just did addition. Fewer did subtraction. Fewer yet did one-digit multiplication. And one or two people in the entire project did division.



Corn

One or two people did division.



Herman

In a project of four hundred and fifty whose entire output was mathematical tables.



Corn

What are the other four hundred and forty-eight doing, then?



Herman

Adding. Adding, a lot, all day, on paper, with a pencil, checked by the person next to them.



Corn

There's a detail I want to bring in here, because it might be the single best illustration of what this work was.



Herman

Go on.



Corn

Gertrude Blanch ran the Mathematical Tables Project. And she had a problem. Her computers did not understand negative numbers. They didn't have the training, the concept wasn't there. So instead of trying to teach negative numbers to hundreds of relief workers, she used colored pencils. Black for positive, red for negative. And there was a sign on the wall. Black plus black equals black. Red plus red equals red. Black plus red, or red plus black, hand the sheets to Group Two.



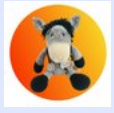
Herman

That's the whole thing, Corn. That's not a mathematician solving a problem. That's an engineer designing around a known limitation in the hardware.



Corn

And the limitation was a human being.



Herman

And she solved it by routing. She wrote a rule that said, when this condition occurs, the work goes to a different station. That's an if-branch. That's literally an if-statement in a dispatch policy.



Corn

But hold on, because Blanch is also the counterexample to the deskilling story. We've just described her building a system for people who couldn't do negative numbers. She had a PhD from Cornell in 1935.



Herman

Right. So the project had extremes inside it. Blanch and Ida Rhodes at the top, both women mathematicians who carried, in the words of the histories, the double stigma of being a woman and being Jewish. And hundreds of workers below them with no mathematics education at all. There's a photograph caption from the period that stuck with me from the Los Alamos side. One of the computers there was described as a girl from Fairfax High School with, as yet, no college education, doing mathematical calculations for some of the world's great scientists.



Corn

Same building. Same calculation. The person checking the arithmetic and the person who couldn't do negative numbers, both called a computer.



Herman

So we've got the desk. Paper, pre-printed forms, mathematical tables, and a mechanical calculator if you were lucky. At Los Alamos they had Marchant calculating machines. Feynman describes them as a glorified adding machine that you work by hand. There's a crank. You turn it. Multiplication is repeated cranking with a shift.



Corn

So even the mechanical assistance was a manual operation.



Herman

Everything was manual. The machines didn't have a memory you could store a program in. The "memory" was a piece of paper and a human being who kept track of intermediate results.



Corn

Which means the human was the register. That's the part I keep coming back to. The person isn't doing the arithmetic the machine can't do. The person is the storage. You finish a step, you write the number down, you carry it to the next form.



Herman

And this is where the worksheets matter. Blanch didn't just assign tasks. She broke the complex equations down into basic component parts and turned them into worksheets. So the worker didn't need to understand the equation. The worker needed to fill in the box correctly, then pass the sheet along. And then the sheets were checked by peers for accuracy before going up to a floor supervisor and then to Blanch.



Corn

So the plan was designed at the top, executed at the bottom, and verified at every stage on the way back up.



Herman

And there's a line from a history of the project that says this foreshadowed the way digital computers break down very complex problems into steps. Which is exactly right, and it's the thesis of the whole episode. They built the machine out of people before the machine existed, and they built it with the same architecture.



Corn

So the answer to Daniel's question about the spectrum is that the spectrum was real, and it was wide, and the job title did not change as you moved along it. That's the strangest part.



Herman

And the deviser and executor distinction was real too, and it was gendered. The MTP's Planning Committee created the algorithms. The computers executed them. And the adding machines, the few they had, were not used by the bulk of the computers. They were used by the project leads for computing initial values and verifying results.



Corn

The people doing the adding didn't get the adding machine.



Herman

The leads got the adding machine.



Corn

What's the joke there. I don't know if there's a joke there. That's just the shape of every office.



Herman

It's the shape of every office, yes. But at Los Alamos the distinction gets more interesting, because the men running the computation lab didn't know how to operate the IBM punch card machines. Naomi Livesay did. She knew not just how to operate them but how to program them. And "program" here means rewiring plug boards.



Corn

Rewiring plug boards.



Herman

Physically. You take a panel, you pull the wires out, you put them back in different holes. That's the program. The calculation is determined by which socket the wire is in.



Corn

So the people running the lab had a machine they couldn't operate, and the person operating it was the person who understood the arithmetic anyway.



Herman

Both. She understood the arithmetic and she understood the wiring. And she was also checking the machine's output by hand. The operation ran twenty-four hours a day, six days a week, machines doing calculation and people, mostly Naomi, checking the results by hand.



Corn

Machines never sleep. People do, badly, on a six-day week.



Herman

Oppenheimer personally came by and asked her how the punch card operation was going and whether she needed anything. So the lab's director understood where the actual bottleneck was.



Corn

So what Daniel calls the "deviser and executor" split, at Los Alamos it's not a split, it's one person doing both ends. Livesay is designing the machine's job and hand-checking the machine's work.



Herman

And that's the blur we should keep. The two-role model is real at the MTP. At Los Alamos it breaks down. Which is a good reminder not to build the whole episode on a clean hierarchy.



Corn

What about the error checking. Because if the entire business is people carrying numbers between sheets, the failure mode isn't a wrong sum, it's a wrong sum that nobody catches until it's in a table or in a bomb design.



Herman

It was designed in. The same calculations were frequently performed independently by separate teams to check the correctness of the results. Redundancy. Independent duplication, then comparison. The Moore School, doing artillery trajectory tables, had women rechecking calculations by hand even after they'd used the differential analyzer.



Corn

So they didn't trust the machine either.



Herman

They didn't trust anything. Which is correct, because the machine was an analog device with gears.



Corn

Let's talk about scale. How much of this was there? Because "some people did calculations" undersells it.



Herman

The Moore School hired over two hundred women for artillery trajectory tables. By 1944, about half of all computers in the United States were women. NACA hired several hundred women as computers at Langley, and NASA employed nearly eighty Black women as computers, which is the story a lot of people know from the film but not from the spreadsheets.



Corn

And the measurement unit for all this labor is the part I can't get past.



Herman

The kilogirl. One contractor used it for a thousand hours of female calculation work. Another unit was the girl-year.



Corn

So the unit of computation was a woman-year of labor. They were literally billing in people.



Herman

They were budgeting in people, which is honest, because that was the machine. If you wanted more throughput, you hired more computers. There was no other lever.



Corn

There's a melancholy in that. The one place where the accounting is completely transparent about what the machine was made of.



Herman

And it was not glamorous. There's a quote from a human computer named Marilyn Heyson. She said, I had moments when I said, did I go to college for this job?



Corn

Every office.



Herman

Yes, but she was doing ballistics. The work mattered. And she's still asking whether she went to college for it, because the work was also repetitive and did not use the thing she'd been trained for.



Corn

So now take the desk we've built and put a few thousand of them in one building.



Herman

Bletchley Park. Roughly seven thousand five hundred women worked there. About seventy-five percent of the workforce. By 1945, of nearly ten thousand personnel, three-quarters were women, and few of them were older than twenty-four.



Corn

Twenty-four. So this is essentially a workplace staffed by people in their early twenties, and it's breaking Enigma.



Herman

And the representative job there is not the famous mathematician. It's the Bombe operator. Jean Valentine worked in Hut Eleven. Her description of the hut is: five machines within the hut, ten girls and one petty officer. She was four foot ten, and she used a footstool to operate the top rotors.



Corn

Four foot ten and a footstool.



Herman

She started at fifteen shillings a week. Seventy-five pence.



Corn

The physical ergonomics of the machine were designed for someone taller.



Herman

Everything was designed for someone else's body. That's a theme across the whole episode. The plug boards, the rotors, the terminal heights, the calculators. None of it was designed for the person who actually had to use it.



Corn

What did the Bombe do, though. Because I want the actual task.



Herman

The Bombe was a mechanical device, and the operator's job was to set it up with a menu, derived from a crib, a guessed word in the message. Then the machine ran through rotor positions, and the operator watched for the machine to stop at a probable setting. The operator's job was to set it, watch the dials, and record and interpret what stopped.



Corn

The operator monitors a machine doing the searching and reads the results.



Herman

Reads the dials, notes the stops, passes the promising ones along. Because the machine generated candidates, and the human filtered them. The machine was fast and dumb. The human was slow and could recognize a hit.



Corn

And the noise.



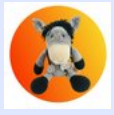
Herman

Joyce Aylard, a Bombe operator at Eastcote, said the machines were loud and noisy. She said, I think I lost my hearing in my right ear from operating these bombes.



Corn

Hearing loss.



Herman

When a code broke, a senior person would shout, "job up." That's how they found out it had worked. Not a screen. Not a printout. Someone shouting across the room that the job was up.



Corn

The signal was a voice.



Herman

In a room where one woman was losing hearing in her right ear. And they worked three eight-hour shifts around the clock in Hut Six, which was dimly lit, poorly heated and poorly ventilated.



Corn

Three shifts. So they had a night shift. A building full of twenty year olds in a poorly heated hut, breaking Enigma at three in the morning, and the good news is someone shouting two words.



Herman

The recruitment, which is a detail I love. In 1942 the Daily Telegraph ran a cryptic crossword competition. Solve it in under twelve minutes. The winners were approached by the military.



Corn

Twelve minutes.



Herman

If you were that good at cryptic crosswords, you were worth recruiting. Which tells you what the skill actually was. Pattern recognition under pressure with incomplete information.



Corn

Which is a completely different skill from the Mathematical Tables Project workers doing single-digit addition.



Herman

Same era. Same word on the paperwork.



Corn

Same suspicion that women couldn't do it. Didn't one section head say something about women not liking intellectual work?



Herman

Yes. One section head at Bletchley opined that women wouldn't like to do any intellectual work. And this is in a building staffed three-quarters by women who were breaking the German cipher.



Corn

The statement is not just wrong, it's wrong in a way that makes you wonder what he was looking at.



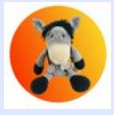
Herman

He was looking at the women doing the work and deciding the work must not be intellectual after all. That's the paradox the historian Mar Hicks names. Computation was feminized precisely because it was seen as rote and de-skilled. The job was coded as low-status because of who was doing it.



Corn

The devaluing came first and the explanation came after.



Herman

The explanation was wrong, because a lot of the women doing these computation jobs actually had to have pretty advanced math skills and math training, especially on the complex calculations. The MTP gives you forty-eight hundred hours of addition with a black pencil. Bletchley gives you a twenty-year-old managing a mechanical logic engine. Both got called "computer."



Corn

Here's the part that makes the lot cohere for me. The MTP worksheets, the routing to Group Two, the peer checking, the redundancy. When the digital computer finally arrives, it doesn't invent that architecture. It inherits it. The people built the method, the method became the machine.



Herman

The machine got the credit and the humans got forgotten. Which is why the Smithsonian's numbers land the way they do. Women were about thirty-five percent of coders in 1990, and twenty-six percent in 2013. The share of women in computing fell as the field became recognized and lucrative.



Corn

The de-skilling story ends the opposite way from how it starts. Because when the work was called unskilled there were women everywhere in it, and when it got called skilled, they dropped out of it.



Herman

Then there's the bit that's harder than any of the numbers. Jane Fawcett was a decoder at Bletchley. She said, we felt slightly ashamed of having only done Bletchley, like also-rans. I'd never told a soul, not even my husband.



Corn

Ashamed.



Herman

Ashamed. Because it was secret, because it was never acknowledged, because everyone was told it was routine work. Churchill called them, the geese who laid the golden egg and never cackled.



Corn

That line cuts both ways. He's praising them for silence and describing what was done to them.



Herman

There's one more thing I want on the record, because it changes how I read the de-skilling numbers. Ida Rhodes, one of the MTP mathematicians, remembered Anne Lowan, the project's statistician. She said Einstein had come by and said to Lowan, what a marvelous job you're doing down there. But everybody was thinking merely of the Tables. Very few people realized the social work. And then she describes what the social work was. Raising the workers from abject and self-despising people into a team that acquired a magnificent esprit de corps.



Corn

They didn't just get the tables out of the people. They rebuilt the people.



Herman

It's the only thing in the research that looks at the project as a thing done to the workers as well as a thing done by them. The same project that asked a woman who'd been to college to do one-digit addition also turned a relief worker into a teammate.



Corn

There's no way to make that clean. It's both. So the answer to Daniel's last question. Individual brilliance, human organization, or both.



Herman

Both, but the interesting part is the mechanism of the "both." The individual brilliance was mostly spent on designing the organization, not on doing the arithmetic. Blanch's contribution wasn't that she could add faster. It was that she could design a floor of four hundred people so that their combined output was correct without any of them understanding what they were computing.



Corn

She wrote a program. The program happened to be made of people and colored pencils.



Herman

That's what the digital computer inherits. The architecture. Break the problem into steps. Find a place to store intermediate results. Route exceptions to a special case. Check independently. Compare.



Corn

The machine is the diagram of the office.



Hilbert

The office got one thing wrong, though.



Corn

Hilbert's been sitting right there the whole time.



Hilbert

I ran the verification floor on a machine like that. Late nineties. Munitions plant, Cray, the punch card sorters. You want to know about the ones who checked the answers.



Corn

Go ahead.



Hilbert

We had forty-one people in the verification hall. Three shifts. The one thing nobody writes down is that the answer sheets went in a specific order. Black at the top of the pile, red underneath. Because the sorter had a habit of running the red forward when the tray got warm, and the only way to catch it was to put the black on top where you'd see it come out wrong first. So you'd stand there with a stack, and you'd be looking at the pile, not at the machine. You were watching the tray more than the dials. That was the job. It took me four months to figure out the order, and then I wrote it on the wall. I still have the marker somewhere.



Corn

You wrote it on the wall.



Hilbert

On the wall. Next to the fire exit. And the tray stopped lying, or at least it lied predictably, which is the same thing if you're paying attention. The girl who ran the night shift used to leave a cup of tea on the tray so the heat would keep it warm in winter.



Corn

A cup of tea on the tray.



Hilbert

Tea on the tray. It worked. She got through the whole winter. Then the plant got a new sorter, a Burroughs, and the tea trick stopped working, and we went back to the black-on-top rule. The Burroughs didn't care about the heat, but the tray was a different depth, so the stack fell over.



Corn

The machine was fine and the tray was the problem.



Hilbert

The tray was always the problem.



Corn

What do we do with that, Herman.



Herman

I think the stack of sheets is the whole episode. The order wasn't in the manual. It was on the wall, next to the fire exit, because somebody stood there long enough to notice.



Corn

That's the thing the histories leave out. The marker on the wall.



Herman

Open questions here. The productivity expectations are a blank in the record. Nobody wrote down how many calculations per hour, or if they did, it didn't survive. We have Cannon classifying stars at three a minute, and we have the kilogirl, which measures how much labor you bought, not what came out of it. And the volume count for the Mathematical Tables Project is inconsistent. One source says twenty-eight, another says thirty-seven. Both are in the record and neither has been reconciled.



Corn

The full social history of these workers is still being written, which is a strange thing to say about a workforce that numbered in the thousands and ran for ten years.



Herman

Fifty years from now, someone will pull a tray out of a storeroom and the note will be missing.



Corn

The kilogirl and the girl-year. The unit of computation was a person, and the person was usually a woman, and the unit was named after her and used to budget her and then the machine took over and the name got retired along with the pencil.



Herman

The next time you use a computer, the word used to mean a person. That person was probably a woman. She was probably following fixed rules. And she was probably standing next to a tray, watching which sheet came out first, because she'd figured out the order on her own and nobody had written it down yet.



Corn

Thanks to Hilbert Flumingtop, our producer, who was sitting right there the entire time. If you enjoyed this one, try episode thirteen, AI; episode twelve, The AI Breakthrough; and episode fifty-eight eighty-seven, Gears That Did Calculus. This has been My Weird Prompts. If you want to send us a prompt of your own, you can do that on Telegram at t dot me slash MWP listener bot, or find the whole archive at my weird prompts dot com.



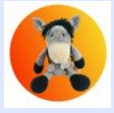
Herman

If you enjoyed this one, leave us a review. It helps.



Corn

We'll be back soon.



Herman

See you tomorrow.

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